

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number
WO 02/02987 A1

(51) International Patent Classification⁷: **F16L 59/06**

(21) International Application Number: **PCT/IT01/00340**

(22) International Filing Date: 27 June 2001 (27.06.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MI2000A001489 30 June 2000 (30.06.2000) IT

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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

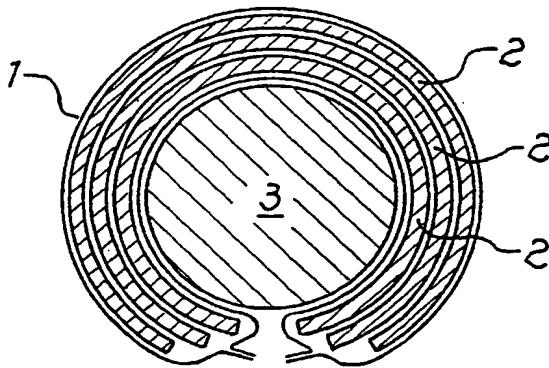
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: EVACUATED PANEL FOR THERMAL INSULATION OF A BODY HAVING NON-PLANAR SURFACES



(57) Abstract: An evacuated panel for thermal insulation of a body (3, 4) having non-planar surfaces provided with two main faces and comprising a flexible envelope (1), made with one or more barrier sheets, and a filling material formed of at least two boards (2; 2') of an open cell polymeric foamed, laying one over the other, each one having a thickness comprised between about 2 and 8 mm.

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"EVACUATED PANEL FOR THERMAL INSULATION OF A BODY
HAVING NON-PLANAR SURFACES"

The present invention relates to an evacuated panel which enables the
5 thermal insulation of a body having non-planar surfaces to be obtained.

Evacuated panels, and particularly those made with plastic materials, are
being increasingly used in all the fields wherein thermal insulation at temperatures
lower than about 100 °C is required. As examples of applications can be
mentioned the walls of domestic and industrial refrigerators, of the drink
10 dispensing machines (wherein thermal insulation is required above all in order to
separate the portion of the hot drinks, generally at about 70 °C, from that of the
cold drinks) or of the containers for isothermal transportation, for instance of
drugs or cold or frozen food. Further, applications of these panels in the building
field or in the car industry are studied.

15 As is it known, an evacuated panel is formed of an envelope wherein a
filling material is provided. The envelope has the function of preventing (or
reducing as much as possible) the entrance of atmospheric gases into the panel, so
as to maintain a vacuum level compatible with the degree of thermal insulation
required by the application. To this purpose, the envelope is made with so-called
20 "barrier" sheets, characterized by having a gas permeability being as low as
possible, which can be formed of a single component but more frequently are
multi-layers of different components. In the case of the multi-layers the barrier
effect is conferred by one of the component layers, whereas the other layers
generally have functions of mechanical support and protection of the barrier layer.

25 The filling material mainly has the function of spacing apart the two
opposite faces of the envelope when vacuum is created in the panel, further to
other features which will be pointed out in the following. This material can be
inorganic, such as silica powder, glass fibers, aerogels, diatomaceous earth, etc.;
or organic, such as rigid foams of polyurethane or polystyrene, both in the form of
30 boards and of powders. The filling material must be anyway porous or
discontinuous, so that the porosities or the interstices can be evacuated. Since the

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permeation of traces of atmospheric gases inside the panel is practically unavoidable, these panels contain in most cases also one or more materials (generally referred to as getter materials) capable of sorbing these gases so as to maintain the pressure inside the panel at the desired values.

5 Because of the rigidity of the materials they are made of, the known panels have generally a planar conformation, and therefore can be used for the insulation of substantially parallelepiped bodies having planar surfaces, but they are not suitable for bodies having curved surfaces, such as bath-heaters or the pipings used for oil transport in the arctic regions, or bodies which are provided with
10 superficial depressions and relieves.

One of the methods used so far for realizing the thermal insulation of bodies having non-planar surfaces consists in connecting to each other several flat panels in the shape of bands, for example by sticking together the edges thereof by means of a glue, so as to obtain a composite structure which can be bent along the junction lines so as to adapt it to the shape of the body which has to be insulated.
15

However, in this kind of structures made of planar panels connected to each other, heat transfers take place at the junctions, and therefore the quality of the heat insulation offered by such structures is scarce.

Patent application WO96/32605 in the name of the British company ICI
20 describes evacuated rigid panels having a non-planar shape and a method for the manufacture thereof, which consists in making in the filling material, prior to the evacuating step, grooves arranged in the desired direction and having suitable width and depth. Subsequently, the filling material is inserted into an envelope and the assembly is subjected to the evacuating step, by means of which the
25 panels bend along the grooves and take on the final, non-planar shape. Finally, the evacuated panel is sealed.

However, it has been observed that in the course of said evacuation the envelope adheres to the filling material and gets at least partially inserted into said grooves so that, when the evacuation is completed, the thickness of the panel is
30 not regular in all the parts thereof, being lower at the bending lines with respect to the planar portions of the same panel. Consequently, also the thermal insulation

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properties are not uniform, but are reduced along these bending lines.

Another drawback of the known non-planar panels consists in the risk that the envelope, which is pressed inside the grooves, breaks thus enabling the passage of atmospheric gases towards the inside of the panel which compromises 5 permanently the properties of thermal insulation of the panel itself.

A further drawback of the known non-planar panels consists in that their curving is made necessarily during the evacuating step, that is, during the process of manufacture of the panels. The accomplishment of said curving notably increases the volume occupied by the panels, whereas it would be convenient to 10 carry it out at the time of the final application of the panel, so as to reduce the difficulties and the costs for transport and storage thereof.

Therefore, object of the present invention is providing an evacuated panel for thermal insulation of bodies having non-planar surfaces which is free from 15 said drawbacks. Said object is achieved by an evacuated panel whose main features are specified in the first claim and other features are specified in the following claims.

An advantage of the evacuated panel according to the present invention consists in that, thanks to the particular structure of the filling material, it can be bent until it adheres to the walls of the body which is to be insulated, with no 20 grooves in the filling material being necessary.

Another advantage of the evacuated panel according to the present invention consists in that, during the curving, the several creases which are formed on the internal side of the curve cannot, because of their small entity, cause a breaking of the envelope itself nor a resulting permeation of atmospheric gases towards the 25 inside of the panel.

Further, the evacuated panels according to the present invention are manufactured, stored and transported to the place of the final application in the flat form, and only subsequently they are curved so that they adhere to the body which has to be insulated.

30 A further advantage of the evacuated panel according to the present invention consist in that it can be manufactured with various thickness values, by

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using a variable number of boards of filling material of a single kind.

Another advantage of the evacuated panel according to the present invention consists in that on the main faces thereof can be made, simply and without carrying out milling operations, one or more depressions complementary to the 5 relieves possibly present on the surfaces of the body which has to be insulated.

Further advantages and features of the evacuated panel according to the present invention will be evident to those skilled in the art from the following detailed description of some embodiments thereof with reference to the accompanying drawings, wherein:

10 - figure 1 shows a cross-sectional view of an evacuated panel according to a first embodiment of the present invention in the flat conformation thereof;

15 - figure 2 shows a cross-sectional view of the evacuated panel of figure 1 in the curved conformation thereof, and

15 - figure 3 shows a cross-sectional view of an evacuated panel according to a second embodiment of the present invention.

With reference to figure 1, there is shown that the evacuated panel according to a first embodiment of the present invention comprises an envelope 1 of known kind, formed for example of two barrier sheets welded along their 20 edges, and a plurality of thin boards 2 of a filling material, equal to each other and placed one above the other inside said envelope 1. The total thickness of the assembly of boards 2 corresponds to the desired panel thickness, provided with only one board of filling material in the panels known so far.

Said boards 2 are preferably made of an open cell polymeric material, and 25 their thickness must be sufficiently low so as to enable the curving thereof. Depending on the polymeric material used, the thickness of the boards can vary between about 2 and 8 mm. It is preferred, as filling material, the use of boards of polyurethane foam having a thickness of about 4-6 mm. These thickness values can be achieved by cutting the boards usually employed for the manufacture of 30 panels of the known kind horizontally, that is, parallelly to their main faces. Alternatively, the thickness of said boards can be reduced by compression,

according to a process known in the field.

With reference to figure 2, there is shown that the evacuated panel according to the present invention has been curved and placed over the lateral surface of a cylindrical body 3, so as to cover it. Curving the panel is possible
5 thanks to the low thickness and to the resulting flexibility of the single boards 2 which it comprises. During the curving step, said boards 2 slide on each other, thus reaching a different final bending radius, and consequently their ends are not aligned any more. In order to favor the reciprocal sliding of the various boards 2, and therefore the panel curving, plastic sheets can be inserted between each pair
10 of adjacent boards.

In figure 3 there is shown an evacuated panel according to a particular embodiment of the present invention, placed on the non-planar surface of a body 4. In the particular case here represented, said non-planar surface is a curved surface comprising for instance a relief 5.

15 The evacuated panel is formed of an envelope 1 containing a plurality of boards 2 of filling material, in this case four. Carvings, having shape and size equal to those of relief 5 of said non-planar surface, have been made in two adjacent boards 2', one of which is next to the envelope 1. Because of the evacuation, the envelope is adherent to the outer surface of the filling material and
20 therefore, at the carvings, to the surface of the internal board 2 which is not carved. In this way one of the main faces of the panel has a depression 6 exactly complementary to said relief 5.

Obviously, the number of the carved boards 2' and the size of the carvings depend on the shape of the depression which is desired on one face of the panel.

25 The panels according to the invention may contain one or more getter materials, that is materials suitable for chemically sorbing moisture and other atmospheric gases. Preferred is the use of systems of two or three getter materials, containing at least one moisture chemical sorber and at least one component selected among a transition metal oxide (having the main function of sorption of
30 hydrogen, CO, and hydrocarbons) and an alloy based on barium and lithium (having the main function of nitrogen sorption). Various getter systems of this

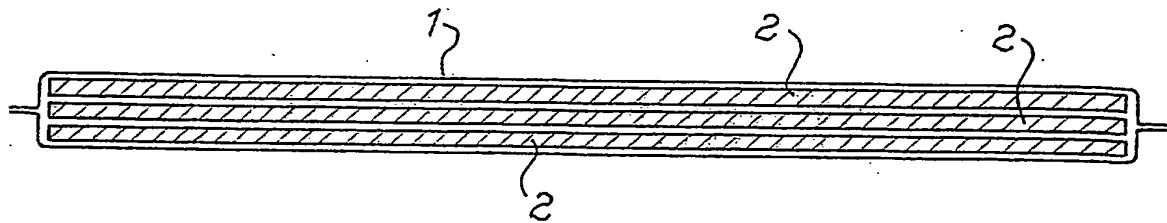
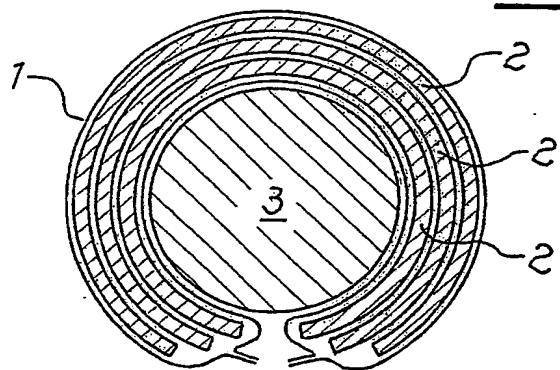
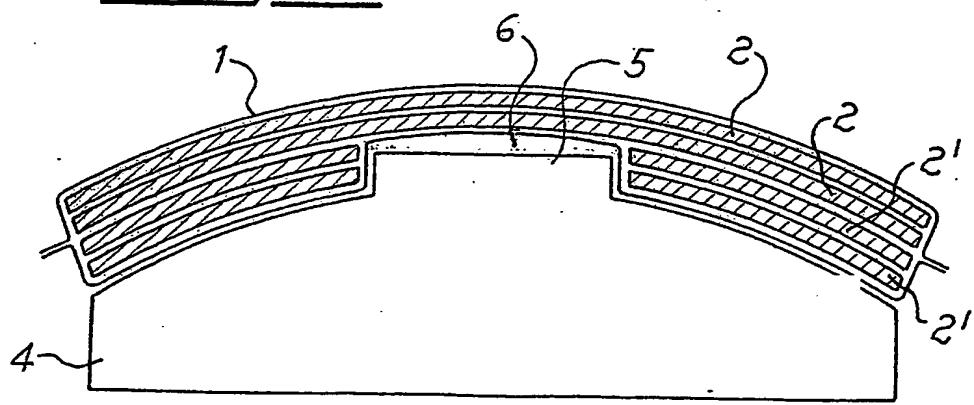
- 6 -

kind are sold by the applicant under the name COMBOGETTER[®], among which in particular systems containing a moisture sorber and powder of alloy based on barium and lithium, described in patent EP-B-769117; and getter systems containing a moisture sorber and a transition metal oxide, with the optional addition of powder of alloy based on barium and lithium, described in patent application EP-A-757920.

CLAIMS

1. An evacuated panel for thermal insulation of a body (3, 4) having non-planar surfaces, provided with two main faces and comprising a flexible envelope (1), made with one or more barrier sheets, and a filling material, characterized in that said filling material is formed of at least two boards (2; 2') of an open cell polymeric foam, laying one over the other, each one having a thickness comprised between about 2 and 8 mm.
2. An evacuated panel according to claim 1, characterized in that it further comprises plastic sheets inserted between each pair of adjacent boards in order to favor their reciprocal sliding.
3. An evacuated panel according to claim 1, characterized in that said boards (2; 2') are made of a polyurethane foam and each one has a thickness comprised between about 4 and 6 mm.
4. An evacuated panel according to one of the preceding claims, characterized in that said boards (2) are substantially equal to each other.
5. An evacuated panel according to claim 1, characterized in that on one or more adjacent boards (2'), one of which is next to the envelope (1), is made at least one carving having shape and size coincident with those of a relief (5) provided on a non-planar surface of said body (4).
6. A panel according to any of the preceding claims, characterized in that the envelope (1) is made of at least one multi-layer sheet.
7. A panel according to any of the preceding claims, characterized in that it contains a getter material or device.
8. A panel according to claim 7 wherein said getter device comprises at least one moisture chemical sorber and at least one component selected among a transition metal oxide and an alloy based on barium and lithium.

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Fig. 1Fig. 2Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IT 01/00340

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16L59/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16L C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>WO 00 61503 A (N.S CONSULTANTS LTD ;AMCON INC (JP); ONODERA SYORI (JP); HANSHIN E) 19 October 2000 (2000-10-19)</p> <p>abstract</p> <p>page 1, line 25 - line 28</p> <p>page 2, line 22 - line 30</p> <p>page 10, line 6 - line 8</p> <p>page 10, line 14 - line 26</p> <p>page 11, line 2 - line 13</p> <p>---</p>	1,4,6-8
A	<p>US 5 843 353 A (BIESMANS GUY LEON JEAN GHISLAI ET AL) 1 December 1998 (1998-12-01)</p> <p>abstract; figures 1-3</p> <p>column 2, line 1 - line 2</p> <p>column 8, line 65 -column 9, line 32</p> <p>---</p>	1,3

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

• Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *^T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *^X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *^Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *^S document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

22 October 2001

30/10/2001

Name and mailing address of the ISA

Authorized officer

Balzer, R

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IT 01/00340

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 824 140 A (HOFMANN A) 16 July 1974 (1974-07-16) abstract; figures 1,5 column 1, line 35 - line 42 -----	5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IT 01/00340

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